

Geological mapwork from models 1: plain with simple geology

Draw and make your own 3D models of the geology of a flat region

A flat region or plain looks like this:



The Serengeti plains in Tanzania, with a mountain in the background.

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Cut out the model of a flat region along all the solid lines. Then fold it along the dashed lines and flatten it out again.

A 3D cut out model of an area of flat ground (scale 1 cm = 100m)

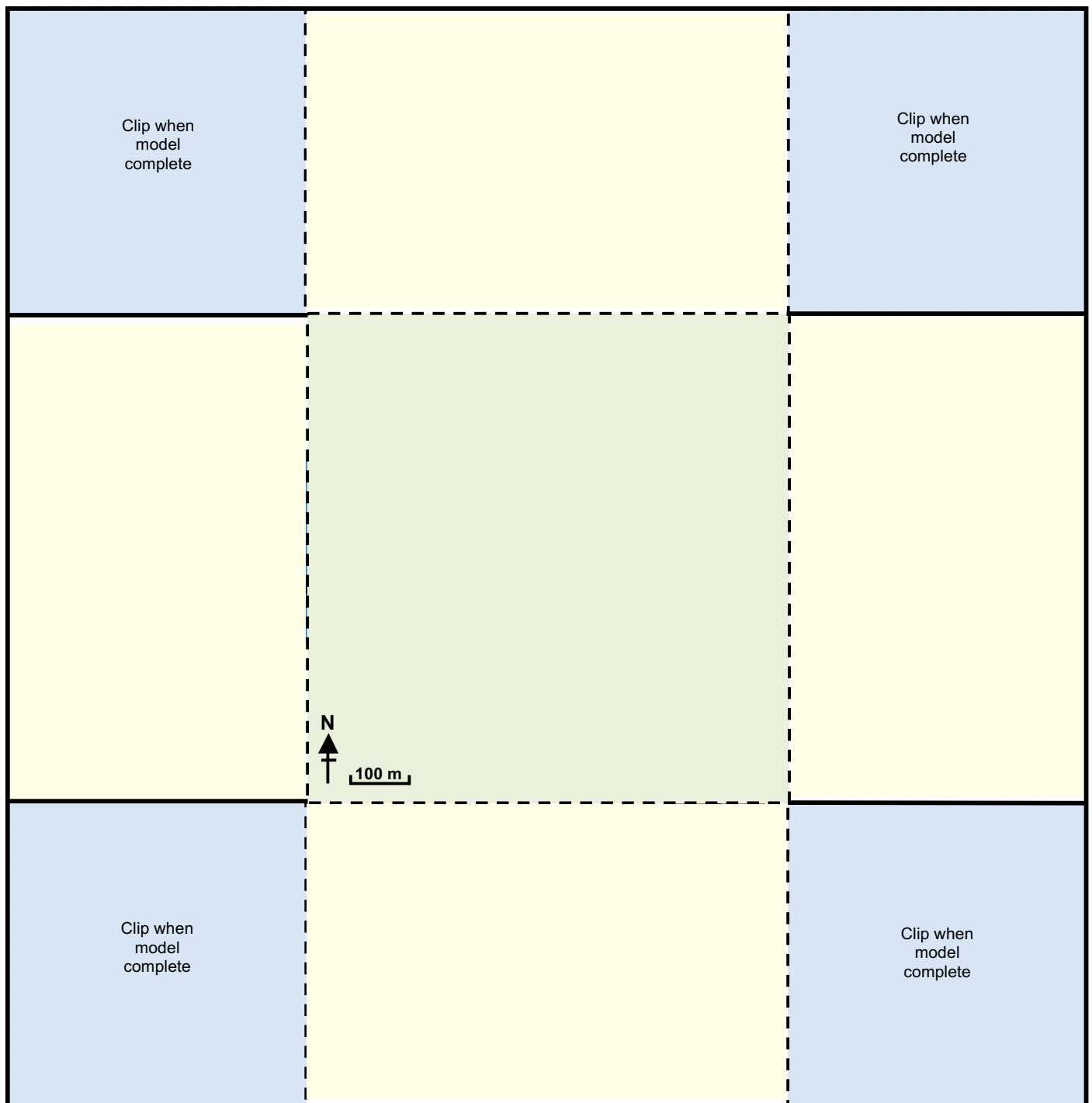
Plain, version 1: Add the following geology to the model using the shading or colours on the key on the next page. Then paper-clip it together to show the 3D geology.

The formations in the area are horizontal. A borehole shows that a 200m thick limestone overlies a 200m thick mudstone on top of a 100 m thick sandstone.

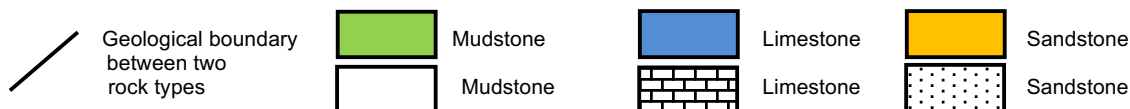
Then either cut out a new model or turn the version 1 model inside out and draw on the North arrow and scale so you can use it to make version 2.

Plain, version 2. Add the following geology to the model and clip it together showing the 3D geology of the area.

The limestone found in the area is 200m thick. Boreholes in the SW and SE corners both show the same succession: 200m of mudstone underlain by 200m of limestone, with sandstone underneath. A borehole in the NW corner shows 100m of limestone, with sandstone beneath. A 20m wide vertical dyke of igneous rock crosses the centre of the area from N to S.



Key for coloured and black and white versions of the model



The back up

Title: Geological mapwork from models 1: plain with simple geology.

Subtitle: Draw and make your own 3D models of the geology of a flat region.

Topic: Part of a series introducing simple geological mapwork – through 3D models. A table of the progression and spiralling of spatial thinking skills involved through the series is given on the final page.

Age range of pupils: 14 – 19 years

Time needed to complete activity: 40 mins

Pupil learning outcomes: Pupils can:

- add geological data to a 3D block model of a flat area;
- link up the data with geological boundaries,
- interpret these into a 3D picture of the geology.

Context:

Pupils are shown a photograph of a plain and then are asked to cut out a 3D paper model of a flat plain-like area. They should use the cut-out to make the first version, then either cut out another model, or turn the first model inside out, to make the second version.

Plain, version 1. Since the geology is horizontal in the area, adding horizontal lines to the cross sections at the sides of the model at the correct depths is relatively simple. When shading or colouring the cross sections, the pupils should realise that limestone crops out at the map surface, and also colour/shade it accordingly.

Plain, version 2. This is more complex, since it has dipping formations and data that need interpolation. Pupils should find it easy to plot the borehole data in the SW and SE corners and link the boundaries with straight horizontal lines. They should then plot the data in the NW corner and, for the western cross section, join the two limestone/sandstone boundaries with a straight line. Since the thickness of the limestone is 200m, pupils should draw a mudstone/ limestone boundary at the same angle, 200m above this boundary; this will intersect the map surface. The depth of the limestone/sandstone boundary will be the same in the NE corner as the NW corner, allowing all the cross sections to be completed. The mudstone/limestone boundary that outcrops on either side of the map should be joined with a straight line. The dyke should be added last, before colouring and paper-clipping the model.

Following up the activity:

For each of the models, pupils could be asked:

1. to draw a geological map of the area;
2. to construct a geological cross section diagonally across the block;
3. if there were a rock exposure in the area, what the dip of the beds would be, and so which of these symbols would be most appropriate to add to the geological map:

- + horizontal beds
- + vertical beds (longest line parallel to the bedding)
- 20° direction of dip (arrow direction) and amount of dip (in degrees from the horizontal) of the beds

(Note: in Model 2, the boundaries dip 20° S).

Underlying principles:

- The three dimensional geological structure of an area can be plotted on block diagrams.
- The surface of a 3D block diagram with a flat surface is a geological map, whilst the sides are geological cross sections.

Thinking skill development:

The drawing of geology onto three dimensional models involves spatial thinking skills. The more complex the geology becomes, the more spatial interpretation is needed, including interpolation and extrapolation skills.

Resource list:

- one or two print-offs of the page containing the block diagram cut-out, per pupil
- scissors (if these are not available, place a ruler flat along the edge to be cut, and tear the paper along the ruler)
- paper clips, four per model
- drawing materials, including pencil, eraser, ruler, protractor and pencil crayons

Useful links:

Higher level mapwork exercises with online tutorials are available for free download from the Open University: http://podcast.open.ac.uk/oulearn/science/podcast-s260_mapwork#

Source: This is the fourth of a series of simple introductory geological map exercises developed by Joe Crossley and Joe Whitehead. Part II of this series of exercises (from which this exercise comes) was published in 'Geology Teaching' the journal of the Association of Teachers of Geology in 1980 (Volume 5, No. 1, pages 15 – 19).

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The progression and spiralling of spatial thinking skills shown by the Earthlearningidea 'Geological mapwork from scratch' exercises and the 'Geological mapwork from models' exercises

Exercise		Topographic surface	Geological surfaces	Strategies and skills
Mapwork from scratch 1: a conical hill		Conical hill	Flat and horizontal	<ul style="list-style-type: none"> Plot and draw simple topographic cross sections Add geological boundary intersections and join with straight, horizontal lines
Mapwork from scratch 2: valley with simple geology		Sloping valley	Flat and horizontal	<ul style="list-style-type: none"> Plot and draw simple topographic cross sections Add geological boundary intersections and join with straight, horizontal lines Sketch geology onto a 3D block diagram
Mapwork from scratch 3: valley with dipping geology		Sloping valley	Dipping surfaces	<ul style="list-style-type: none"> Draw true dip on a cross section using a protractor Add geological boundary intersections and join with straight lines Appreciate that apparent dip is always less than true dip Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip. Sketch geology onto a 3D block diagram Begin to compile a list of mapwork rules
Mapwork from models 1	Plain version 1	Flat	Flat and horizontal	<ul style="list-style-type: none"> Add geological boundary data to cross sections and join with straight, horizontal lines
	Plain version 2	Flat	Dipping surfaces; vertical feature	<ul style="list-style-type: none"> Add geological boundary data to cross sections and join with straight lines Use boundaries on the cross sections which intersect the topographic surface to draw a boundary on the surface Add a vertical feature (dyke)
Mapwork from models 2	Cuesta version 1	Asymmetrical ridge	Flat and horizontal	<ul style="list-style-type: none"> Add geological boundary data to cross sections to construct straight, horizontal lines
	Cuesta version 2	Asymmetrical ridge	Dipping surfaces; vertical feature	<ul style="list-style-type: none"> Draw true dip on a cross section using a protractor Add parallel geological boundaries Add a vertical feature (fault) that moves a geological boundary Appreciate the link between tough and weak geological formations and topography
Mapwork from models 3: valley with horizontal floor		Valley with horizontal floor	Dipping surfaces; vertical feature	<ul style="list-style-type: none"> Draw true dip on a cross section using a protractor Add parallel geological boundaries Use boundaries on the cross sections which intersect the topographic surface to draw in boundaries on the surface Construct parallel boundaries on the surface Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip Appreciate that apparent thickness is always greater than true thickness Add a vertical feature (dyke)
Mapwork from models 4	Ridge/ valley with sloping floor version 1	Ridge/ valley with sloping floor	Dipping surfaces	<ul style="list-style-type: none"> Add geological boundary data to cross sections to construct straight lines Add parallel geological boundaries Appreciate the link between tough and weak geological formations and topography Interpolate approximate true dip from apparent dip
	Ridge/ valley with sloping floor version 2	Ridge/ valley with sloping floor	Dipping surfaces	<ul style="list-style-type: none"> Draw true dip on a cross section using a protractor Add parallel geological boundaries to cross sections Use boundaries on the cross sections which intersect the topographic surface to draw in boundaries on the surface Construct parallel boundaries on the surface Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip and the opposite is true of ridges
Mapwork from models 5: plain; cuesta; valley with horizontal floor; ridge/ valley with sloping floor		All the model landforms above	Surfaces folded into open folds	<p>The strategies and skills described in the box above and, in addition:</p> <ul style="list-style-type: none"> Identify folds with equally dipping limbs, and those with limbs dipping at different angles Appreciate inverted topography Draw fold axes and fold axial planes Draw an unconformity and a pluton with a metamorphic aureole
Geological mapwork: Surface geology and the geological map		Not given, assumed fairly flat	Relatively complex	<ul style="list-style-type: none"> Match surface geological features to places on a geological map where they might be found.